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Pay-Performance Sensitivity and Risk-taking Behaviors: Evidence from Closed-end Funds

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Abstract

The pay-performance sensitivity (PPS) of managers of closed-end funds is explicitly specified in their contracts as the marginal rate of the funds' net asset value. Using a sample of US closed-end funds from 2006 to 2009, this paper investigates the relationship between the PPS and risk-taking behaviors of fund managers. After controlling for endogeneity, we find that fund return volatility and fund PPS positively determine each other. Furthermore, the positive relationship is more pronounced for closed-end funds engaging in alternative investments or in emerging markets.

Keywords: Closed-end fund, pay-performance sensitivity, risk-taking behavior, alternative investments, emerging market

JEL classification: G23, M12, M52

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1 Introduction

According to Morningstar's fund database, more than 2,700 closed-end funds were listed by the end of June 2010, amounting to more than $800 billion. Over all the years in our sample, the average management compensation for a closed-end fund is $3.72 million. The management compensation for a closed-end fund is usually specified either as a single percentage of the underlying net asset value (NAV)[c] or as multiple marginal rates applied to different bands of the underlying NAV.[d] Despite its importance, significant size and unique institutional features, the managerial incentive compensation of closed-end funds remains under-researched. This paper sheds light on the issue by investigating the relationship between pay-performance sensitivity (PPS) in the management contract, and risk-taking behavior, for the closed-end fund industry.

Performance-related pay is viewed as incentive compensation designed to resolve the principal-agent problem between shareholders and managers. CEO compensation at conventional firms normally includes a fixed salary plus stock options. Gillan, Hartzell and Parrino (2009) suggest that the overall CEO compensation structure for firms in the S&P 500 is not specified in the contract for the entire life of the firm. Therefore, previous literature on conventional firms normally estimates PPS using linear regressions on the actual ex post

[c] The typical management contract for a closed-end fund with a single marginal compensation rate is as follows: "The fund will pay a management fee at an annual rate of 0.75% of the fund's average weekly net assets, calculated weekly and payable on the first business day of each month". In this paper, we use the fixed annual rate as the applicable marginal compensation rate (fund PPS), instead of using the fixed rate multiplied by the average of weekly net asset values.

[d] The typical management contract for a closed-end fund with multiple marginal compensation rates is as follows: "The fund will pay a management fee at the annual rate of 0.65% of the fund's average weekly managed assets for up to $200 million, 0.60% of managed assets between $200 million and $500 million and 0.55% for managed assets in excess of $500 million, calculated weekly and payable on the first business day of each month". In this paper, we use the fixed annual rate that applies to the actual NAV in that year as the applicable marginal compensation rate (fund PPS), instead of using the fixed rate multiplied by the average of weekly net asset values.

compensation provided to the CEO and other executive directors (see Jensen and Murphy 1990; Hall and Liebman 1998; Aggarwal and Samwick 2002; Jin 2002; Dee, Lulseged and Nowlin 2005). By contrast, the compensation paid to the fund manager of a closed-end fund is explicitly specified in the management contract, which is renewed each year at the annual general meeting. Although an open-ended mutual fund has a similar management compensation structure, its fund size varies not only with the fund performance but also with the continuous new issues and redemptions of outstanding shares. The applicable marginal compensation rate (percentage-of-assets) in the management contract is not an appropriate proxy for a mutual fund's PPS. In comparison, the number of outstanding shares in a closed-end fund are normally fixed after the IPO. The change in the underlying NAV of a closed-end fund mainly results from its investment performance, rather than from new investments or the redeeming of shares. Accordingly, the applicable marginal compensation rate defined in the management contract is the most appropriate proxy of the fund manager's PPS for a closed-end fund (see Coles, Suay and Woodbury 2000; Deli 2002). Consequently, the closed-end fund industry provides a useful experimental environment in which to use the applicable marginal compensation rate in the management contract as a good proxy for the fund PPS.

The relation between risk-taking and managerial incentives is of primary importance, because an efficient management compensation contract should make a trade-off between the correct managerial incentives (PPS) and the optimal amount of risk sharing by executives (see Holmstrom and Milgrom, 1987). Smith and Stulz (1985) assume that the utility function of risk-averse executives is a concave function of the expected wealth, and that shareholders utilize the compensation structure to change the risk tolerance of executives. To the best of our knowledge, this is the first study on whether and how a fund's PPS and its risk-taking behavior determine each other in the closed-end fund industry.

In this study, we examine the full sample of 2,351 fund-year observations for US closed-end funds traded at any time between 2006 and 2009. In the sample, 19.1% of funds invest in alternative assets, and 5.9% invest in emerging markets; 33.8% of fund-years have multiple marginal rates (concave contracts), while 66.2% of fund-years have a single marginal rate (linear contracts). For a fund with multiple marginal rates in the contract, the PPS is the marginal rate that applies to the actual NAV in that year. A fund's investment risk is measured by its NAV return volatility.

To account for the endogenous relationship between fund risk-taking behavior and fund PPS, we apply simultaneous equation models to investigate how these two factors are jointly determined. We find that fund risk has a significantly positive impact on fund PPS, which confirms the prediction of the managerial ownership model but is contrary to the implications of the standard principal-agent model. Also, fund PPS imposes a significantly positive effect on the level of fund risk, which proves that, in the closed-end fund industry, out of the two incentives provided by PPS, the increase in the value of the fund manager's portfolio outweighs the negative effect of increased volatility on the manager's expected utility. Moreover, the positive relationship between fund return volatility and fund PPS is stronger for closed-end funds that make alternative investments or invest in emerging markets.

This study contributes to the literature in a number of ways. First, it contributes to the work of fund compensation such as Coles, Suay and Woodbury (2000) and Deli (2002). Second, it adds to the work done on the risk-taking of funds, by researchers such as Buraschi, Kosowski and Sritrakul (2014). Third, it extends the study of closed-end fund investing in alternative assets and in emerging markets, adding to work done by Bekaert and Urias (1996).

The rest of this paper is structured as follows. Section 2 reviews the previous literature and develops hypotheses. We introduce the data and methodology in Section 3. In Section 4, we report and discuss the empirical results. Finally, we draw conclusions in Section 5.

2 Literature Review and Hypotheses

Closed-end funds are managed by external management companies, implying that the delegated decision rights may cause conflicts of interest between fund managers and fund shareholders, leading to the classic principal-agent problem. As is generally indicated in the principal-agent literature, the primary means to ensure that managers take actions to maximize the returns to shareholders is to tie their compensation to the performance of their firms. As described in the introduction of this paper, the PPS of a closed-end fund is the applicable marginal compensation rate, which is a percentage of the underlying NAV, specified in the management contract each year. In rare cases, closed-end funds compensate fund managers with a proportion of the excess performance over a specified benchmark. As argued in the theoretical analysis of Admati and Pfleiderer (1997), benchmark-adjusted performance compensation is not optimal in terms of incentive alignment and efficient risk sharing. Deli (2002) suggests that percentage-of-assets contracts are the norm in the closed-end fund industry.

2.1 The Effect of Risk on Fund Pay-Performance Sensitivity

The primary assumption of principal-agent theory is that incentives are necessary to induce costly efforts from agents in situations with information asymmetry (see Mirrless 1974, 1976; Ross 1973; Shavell 1979). Accordingly, an efficient management compensation contract should make a trade-off between the correct managerial incentives (PPS) to ensure the agent's unobservable effort and the optimal amount of risk sharing by the agent, as derived in Holmstrom and Milgrom (1987). They predict that a risk-averse manager is more likely to make their compensation less sensitive to the performance of a firm with higher risk.

Moreover, as indicated in Stiglitz (1987) and Eisenhardt (1989), the basic risk aversion assumption in agency theory is that agents do not like variability or risk in their compensation. Accordingly, Bloom and Milkovich (1998) suggest that a greater amount of firm risk may be transferred to the agents by reducing their income and employment stability. They argue that when firm risk is higher, greater PPS may become dysfunctional in terms of directing managers' behavior because it will just impose more risk. Therefore, similarly to Holmstrom and Milgrom (1987), they expect that a risk-averse manager's PPS should be a decreasing function of the firm risk or the variance of firm performance.

Other papers have confirmed this prediction, mainly using data on conventional US firms (for example, Lambert and Larcker 1987; Kimmel, Kren and Schadewald 1995; Aggarwal and Samwick 1999, 2002; Jin 2002; Miller, Wiseman and Gomez-Mejia 2002).

Holmstrom and Milgrom (1987) only emphasize the assumption of the risk-aversion of managers. However, uninformed shareholders can only observe the selected projects rather than the reasons motivating managers' selections. This information asymmetry is more severe in riskier firms and can induce an adverse selection problem. To motivate risk-averse managers to select investment projects optimally (rather than excessively favoring low-risk projects), shareholders need to provide greater compensation incentives (higher PPS) to the managers of riskier firms.

Following this rationale, Demsetz and Lehn (1985) extend standard agency theory to derive a managerial ownership model and predict a positive effect of firm risk on PPS. This is supported by Prendergast (2000, 2002) and evidence from Core and Guay (1999, 2002). Coles, Daniel and Naveen (2006) also find that stock-return volatility has a positive effect on firm PPS. This prediction is also confirmed by the evidence from emerging markets gathered in Huang, Wu and Liao (2013), which studies the relationship between equity-based compensation and managerial risk-taking in Chinese listed firms.

Similarly, Deli (2002) points out that it is optimal for the management contract to provide a larger applicable marginal compensation rate when it is more difficult to monitor the fund manager's actions or the fund's performance. Generally, the difficulty of monitoring fund performance is captured by a fund's total investment risk.

To summarize, on the one hand, if standard agency theory applies to the closed-end fund industry, then a corresponding null hypothesis is that the fund manager of a closed-end fund with higher risk is awarded a lower marginal compensation rate (PPS) in the management contract. On the other hand, according to the prediction of the managerial ownership model, a closed-end fund's marginal compensation rate is expected to be in line with its total risk. This leads to the following hypothesis:

H_1: The fund manager of a closed-end fund with higher risk is awarded a greater marginal compensation rate (PPS) in the management contract.

2.2 The Effect of Pay-Performance Sensitivity on Fund Risk

The evidence on how increased PPS affects managerial risk-taking incentives for conventional firms is inconclusive, probably because of the mixed incentives provided by PPS. As a consequence, the impact of PPS on firm risk-taking behavior seems to depend on which incentive provided by the PPS dominates (see Low 2009).

On the one hand, increased PPS increases the alignment of interests between managers and shareholders, because they share the losses and gains (see Jensen and Meckling 1976). Higher PPS should therefore increase managers' efforts and lead to better performance. At the same time, John and John (1993) suggest that if higher NPV projects tend to be relatively more risky, increased PPS may motivate managers to implement riskier projects. Grinblatt and Titman (1989) show that fund managers who hedge their incentive fees try to maximize the value of the fees by increasing fund leverage as much as possible. A considerable body of theory posits that equity-based compensation is awarded to managers to overcome managerial risk aversion and encourage them to invest in high-risk, high-return projects on behalf of risk-neutral shareholders (see for example Haugen and Senbet 1981; Smith and Stulz 1985; Lambert 1986; Copeland and Weston 1988; Lambert, Larcker and Verrecchia 1991; Hirshleifer and Suh 1992; Murphy 1999; Hemmer, Kim and Verrecchia 1999). In their empirical study, Massa and Patgiri (2009) find that the incentives contained in contracts have a positive effect on fund risk-taking in the mutual fund industry.

On the other hand, as indicated in Low (2009), increased PPS exposes managers to greater firm risk, aggravating the risk aversion problem. Higher PPS leads to a greater reduction in a manager's portfolio value if the firm's stock price falls. In fact, increased firm risk increases the volatility of the manager's total firm-specific wealth, which includes her portfolio of stocks and stock options, firm-specific human capital (see Amihud and Lev 1981; Smith and

Stulz 1985), and perquisite consumption (see Williams 1987). Similarly, Carpenter (2000) and Ross (2004) show that equity-based compensation does not necessarily lead to increased risk-taking because it can increase the sensitivity of the manager's portfolio to firm stock price movement. Moreover, Hirshleifer and Suh (1992) show that although equity-based compensation can encourage managers to work hard, it can also affect their attitude toward project risk and may lead to too little risk-taking. In empirical research, Lewellen (2006) finds that a higher degree of option ownership tends to decrease managers' preference for debt financing. Gormley, Matsa and Milbourn (2010) find evidence that managers whose compensation contracts have a high sensitivity to stock price appear to reduce their risk-taking in response to the exogenous increase in downside risk. Kempf, Ruenzi and Thiele (2009) investigate the risk-taking behavior of mutual funds and find that when employment risk is more important than compensation incentives, fund managers with poor mid-year performance tend to decrease risk to prevent potential job loss. When employment risk is low, compensation incentives dominate, and fund managers with poor mid-year performance increase risk to catch up with the mid-year winners.

To a fund manager, if the negative incentive from PPS (higher PPS would increase the volatility of her expected utility) outweighs the positive incentive from PPS (higher PPS would increase the value of her portfolio of stocks and stock options), a higher marginal compensation rate (PPS) is predicted to make the fund manager take a lower level of investment risk. However, if the positive incentive from PPS (higher PPS would increase the value of her portfolio of stocks and stock options) dominates, then the impact of the PPS specified in the management contract on the level of risk-–taking in the closed-end fund industry is predicted in the following hypothesis:

H_2: A higher marginal compensation rate (PPS) specified in the management contract motivates fund managers to take a higher level of investment risk.

Investing in alternative assets or emerging markets will increase the investment risk of closed-end funds (see Bekaert and Urias, 1996), and increased investment risk will strengthen the relationship between PPS and fund risk. Therefore, we expect that

H_3: For closed-end funds investing in alternative assets or emerging markets, the relationship between PPS and fund risk is intensified.

2.3 The Endogenous Relationship

From Hypotheses 1 and 2, it can be seen that a closed-end fund's PPS included in the management contract and its risk-taking behavior seem to be interrelated, or there is an endogenous relationship between these two factors. Low (2009) indicates that empirical evidence on the effect of equity-based incentives on managerial risk-taking is inconclusive mainly because endogeneity issues often cloud the interpretation of the relation between equity-based incentives and firm risk. The endogenous relationships that emerge among governance mechanisms and managerial decisions in the extant literature are normally addressed through simultaneous equation models. For instance, Coles, Daniel and Naveen (2006) examine how managerial incentives and investment and financial policies are jointly determined. Billett, King and Mauer (2007) investigate the endogeneity between leverage and bondholder governance represented by debt covenants. John, Litov and Yeung (2008) and Coles, Daniel and Naveen (2009) examine the interactive relationship between management entrenchment and investment policy. John and Litov (2009) study the endogeneity between managerial entrenchment and leverage. King and Wen (2011) test the interactive relationship between shareholder governance, bondholder governance and managerial investment policy. Thus, in order to avoid spurious inferences and to isolate causation, the empirical design of this paper needs to disentangle how fund PPS affects risk-taking behavior from how fund risk affects the fund PPS specified in the management contract each year. Therefore, a critical part of this paper involves accounting for how fund PPS and fund risk-taking behavior are jointly determined, which is achieved with simultaneous equation models.

In addition, in the previous literature, conclusions regarding the risk-taking incentives linked to equity-based compensation are often inferred through financial decisions and investment policies, instead of firm risk itself. Low (2009) discusses how such financial and investment policies often affect managerial incentives in complicated ways, making it difficult for researchers to interpret results solely in terms of risk considerations. Therefore, in this paper, we examine fund risk directly to summarize the net effect of all managerial risk-taking activities, including some that cannot easily be measured by the econometrician, so as to provide a more accurate portrayal of fund managers' risk-taking behavior.

3 Data and Methodology

The management compensation contract information contained in Morningstar's fund database starts from the year 2006. Thus, two years of data are available before the financial crisis of 2008. To include representative years both before and after the financial crisis, the sample period studied in this paper is from the year 2006 to the year 2009. The sample includes the population of US closed-end funds traded on the New York Stock Exchange, the American Stock Exchange and the NASDAQ Stock Exchange at any time between 2006 and 2009. There are 578 closed-end funds in 2006, 573 in 2007, 607 in 2008 and 593 in 2009, making a final panel dataset of 2,351 fund-year observations. To examine the relationship between fund PPS and fund risk-taking behavior, we collect all relevant data from Morningstar's fund database. The data include the applicable marginal compensation rate (PPS) and the type of management contract (single or multiple compensation rates) for each fund in each sample year, the monthly NAV returns over each sample year and the previous year, the value of the total expenses of each fund during each sample year, the monthly NAV of each fund during each sample year, the value of the sales and purchases of underlying investments by each fund in each sample year, and the IPO date and investment policy of each fund.

3.1 Simultaneous Analysis of the Relationship

A closed-end fund's PPS as specified in the management contract, and its risk-taking behavior, seem to be interrelated. Following the lead of the previous literature illustrated in Section 2.3, it is critical to account for the endogenous relationship between these two factors by applying simultaneous equation models to investigate how they are jointly determined.

We estimate the system simultaneously using the instrumental variables approach. The structural set-up is described in equations (1) and (2) below:

$$\begin{aligned} \textit{Fund PPS}_{it} = {} & \alpha_{it} + \beta_1 \textit{Predicted fund return volatility}_{it} + \beta_2 \textit{Alternative dummy}_{it} \textit{*Predicted} \\ & \textit{fund return volatility}_{it} + \beta_3 \textit{ Emerging dummy}_{it} \textit{ *Predicted fund return} \\ & \textit{volatility}_{it} + \beta_4 \textit{ Alternative dummy}_{it} + \beta_5 \textit{ Emerging dummy}_{it} + \beta_6 \textit{ Linear} \\ & \textit{contract dummy}_{it} + \beta_7 \textit{ Expense ratio}_{it} + \beta_8 \textit{ Turnover} \\ & \textit{ratio}_{it} + \beta_9 \textit{ Lnsize}_{it} + \beta_{10} \textit{ Fund age}_{it} + \beta_{11} \textit{ Median PPS}_{it} + \beta_{12} \textit{ Year} \\ & \textit{dummies}_{it} + \beta_{13} \textit{Segment dummies}_{it} + \varepsilon_{it} \end{aligned} \tag{1}$$

where i represents the fund. The dependent variable is the applicable marginal compensation rate (PPS) of the fund during each sample year. For a linear contract, the PPS is the single compensation rate specified in the contract each year, expressed as a percentage. For a concave contract, Coles, Suay and Woodbury (2000) state that although different marginal rates of compensation apply to different levels of NAV, only one such rate is particularly relevant, and it is defined as the applicable marginal compensation rate. This applicable marginal compensation rate is the compensation rate specified in the contract that corresponds to the interval NAV that equals the most recent year-end NAV as reported in either the proxy statement or the annual report for the corresponding year, expressed as a percentage. They argue that, as a practical matter, this applicable marginal compensation rate is a good measure of PPS, which is the percentage of a relatively “small” change in NAV that will be captured or lost by the fund manager. To test the first hypothesis, we measure the total investment risk of the fund, using the standard deviation of the monthly NAV returns over the sample year, expressed as a percentage. To test Hypothesis 3, we control for interaction terms of investment risk with both an alternative dummy and an emerging dummy. The alternative dummy equals one if the closed-end fund invests in alternative assets, and zero otherwise. The emerging dummy equals one if the closed-end fund invests in emerging markets, and zero otherwise.

We also control for other factors that may affect the fund’s applicable marginal compensation rate. Specifically, different contract types may have different levels of applicable marginal compensation rates. The linear contract dummy is set to one if the management contract contains a single marginal compensation rate and zero if it contains a series of marginal compensation rates, declining as the fund size increases.

Coles et al. (2000) suggest that higher costs may reflect higher management quality or that more effort is required to collect the information needed to make value-increasing portfolio decisions. Accordingly, fund expenses are predicted to be positively related to the fund’s applicable marginal compensation rate (or, equally, to the PPS). We measure fund expenses by the expense ratio, which is total expenses as a percentage of average NAV during the sample year.

Deli (2002) states that, in addition to aligning the interests of the fund manager and the shareholders, marginal compensation rates are used as a mechanism for signaling the fund manager's marginal product. He implies that the level of portfolio trading activity is positively related to the quality of management information and therefore directly related to the marginal product of the fund manager. As a consequence, the marginal compensation rates for funds with higher turnover are expected to be greater than those for funds with lower turnover (see Coles et al. 2000; Deli 2002; Cashman 2010). The turnover ratio is the absolute value of the difference between sales and purchases of underlying investments by the fund, as a percentage of average NAV during the sample year.

Deli (2002) implies that the negative relationship between fund size and fund PPS is consistent with economies of scale being passed along to investors, while a reduction in the management's marginal product is proven by Cashman (2010) to make PPS an inverse function of fund size. We measure fund size by *Lnsize*, which is the logarithm of the average monthly NAV of the fund during the sample year.

Coles et al. (2000) argue that new funds are expected to attract more attention and effort from managers, leading to a higher marginal product and therefore greater marginal compensation rates than old funds. Accordingly, we control for a fund age variable that equals the number of trading days between the end of the sample year and the fund IPO date, divided by 250 (the approximate number of trading days in one year).

Kini and Williams (2012) argue that each industry may set a standard compensation structure for all firms in that industry. They find that the industry-median CEO PPS positively affects the CEO PPS of individual firms. Accordingly, in this study, the segment-median PPS (which is defined below) is predicted to be positively related to the fund PPS. The segment-median PPS is the median manager's applicable marginal compensation rate for all funds in the same segment (foreign bond sector, foreign equity sector, domestic equity sector or domestic bond sector) during each sample year.

Finally, we control for year dummies for the sample years of 2006, 2007 and 2009 to examine year effects, using the year 2008 as the base to avoid multicollinearity. Also, we use three segment dummy variables – for the foreign bond sector, the domestic equity sector and the domestic bond sector – to control for different fund investment policies, using investments in foreign equity securities as the base to avoid multicollinearity. Table 1 provides definitions of all the variables used in the analyses.

[Insert Table 1 about here]

The independent variable of predicted fund return volatility is computed by estimating a first-stage regression in which fund return volatility is the dependent variable and the independent variables include all the exogenous variables from the second-stage fund PPS regression and the chosen instrument. The predicted value of fund return volatility is then employed as an independent variable in lieu of its actual value in the second-stage regression. Here, the chosen instrument is the segment-median fund return volatility, which is the median standard deviation of monthly NAV returns across all funds in the same segment over the sample year in question, expressed as a percentage. Roberts and Whited (2011) suggest that the most important characteristic for a valid instrument is that it will affect the second-stage variable only through its effect on the first-stage endogenous variable, based purely on economic arguments. Accordingly, we believe that the segment-median fund return volatility is a valid instrument because the segment may set a standard for the return volatility of any fund in that segment (with the same type of investment policy). At the same time, it is unlikely that this segment-level instrument will have a direct impact on fund PPS after adjusting for segment and year effects. Moreover, this segment-median return volatility is not predicted to be affected by any individual fund's decisions and, therefore, it is more likely to be orthogonal to the residuals of the second-stage regression than any of the fund-level instruments. Despite these arguments, we still examine the validity of the instrument using an F-test to ensure that the F-statistic associated with the endogenous variable in the first-stage regression is statistically significant.

$$\textit{Fund return volatility}_{it} = \alpha_{it} + \beta_1 \textit{ Predicted PPS}_{it} + \beta_2 \textit{ Fund return volatility}_{i(t-1)} + \beta_3 \textit{ Alternative dummy}_{it} \textit{*Predicted PPS}_{it} + \beta_4 \textit{ Emerging}$$

$$dummy_{it} \text{ *Predicted } PPS_{it} + \beta_5 \text{ Alternative } dummy_{it} + \beta_6 \text{ Emerging } dummy_{it} + \beta_7 \text{ Linear contract } dummy_{it} + \beta_8 \text{ Expense } ratio_{it} + \beta_9 \text{ Turnover } ratio_{it} + \beta_{10} Lnsize_{it} + \beta_{11} \text{ Fund } age_{it} + \beta_{12} \text{ Median fund return } volatility_{it} + \beta_{13} \text{ Year } dummies_{it} + \beta_{14} \text{ Segment } dummies_{it} + \varepsilon_{it} \qquad (2)$$

where the dependent variable is the standard deviation of monthly NAV returns over each sample year, as a percentage. To test Hypothesis 2, we control for other factors that may influence the fund return volatility. Massa and Patgiri (2009) find that mutual fund return volatility is positively affected by lagged fund return volatility, fund expenses, turnover ratio and fund size. They find that fund age has a mixed effect on return volatility. Mutual funds with linear contracts are shown to be more likely to have higher fund return volatility than mutual funds with concave contracts. As discussed above, the segment-median fund return volatility is predicted to set the standard for the return volatility of any given fund in the same segment and, therefore, is expected to be positively related to fund return volatility. Finally, we include both year and segment dummies as in equation (1). To test Hypothesis 3, we also control for interaction terms of fund PPS with both an alternative dummy and an emerging dummy. All control variables are defined as above.

In this model, fund PPS is first regressed against all the exogenous variables in the system and the instrument, and then the predicted values are computed. The instrument used is the segment-median PPS and which were shown previously to pass all the relevance and validity conditions for such instrument. Next, fund return volatility is regressed against both the predicted fund PPS and the other control variables, as in equation (2).

4 Empirical Findings

4.1 Descriptive Statistics

Table 1 reports the descriptive statistics for all variables used in the empirical analysis. Panel A shows the measure of fund investment risk. The average value of fund return volatility is 6.09%, with a median of 3.209%. The maximum fund return volatility is 2818.707%.

Panel B presents the descriptive statistics for the measure of fund PPS. The mean and median applicable marginal compensation rates show that the management contracts of US closed-end funds specify average and median annual rates of 0.684% and 0.65% of the corresponding underlying NAV as the compensation for fund managers. This implies that a $1,000 increase in the fund's NAV will increase the fund manager's compensation by $6.84 on average, with a median increase of $6.5. These numbers are higher than the $5.46 mean and $5 median found by Coles et al. (2000), which are also related to US closed-end funds but are based on earlier data covering the period from 1978 to 1991. The results found here are similar, though, to the estimate of CEO PPS of $6.59 found by Aggarwal and Samwick (1999) for large US public companies, using data for the period from 1993 to 1996. In the present study, the maximum PPS found was $18.6 for the Taiwan Greater China fund, which invests most of its assets in the equity securities of foreign companies.

Regarding the control variables in Panel C, the mean values of the alternative dummy and the emerging dummy suggest that, out of the 2,351 fund-year observations, around 19.1% invest in alternative assets and 5.9% invest in emerging markets. The mean value of the linear contract dummy variable indicates that, out of the 2,351 fund-year observations, 66.2% have a linear management contract with a single compensation rate and 33.8% have a concave management contract with multiple compensation rates. The average values of the other variables are 4.93% for the lagged fund return volatility, 1.253% for the expense ratio, 48.672% for the turnover ratio, \$510.941 million for the size, 19,524 for *Lnsize* and 11.435 years for the fund age. On average, the segment-median level of fund return volatility is 3.664%, and that of fund PPS is 0.675%.

Table 2 presents the results of the univariate analysis on the mean values of the two main variables, fund PPS and fund return volatility. To examine how fund return volatility affects fund PPS, we compare the mean values of fund PPS for two subsamples, formed by taking those funds with return volatility below and, respectively, above the median. To examine how fund PPS affects fund return volatility, we compare the mean values of fund return volatility for two subsamples based on PPS (those funds with below and above the median fund PPS, respectively). The tests show that the mean PPS of the sample with fund return volatility below the median is significantly smaller than that of the above-median-volatility sample, at a 1% significance level. Therefore, fund PPS seems to be positively affected by fund return volatility, which supports Hypothesis 1. The mean fund return volatility of the sample with

PPS below the median is also significantly lower than that of the above-median-PPS sample, at a 5% significance level. This finding apparently confirms Hypothesis 2 – that fund PPS has a positive effect on fund risk. The univariate tests consider each of the variables independently. However, the influences on both fund PPS and fund risk are very likely to be simultaneously related to all of the other control variables. It is therefore difficult to fully examine the hypotheses through univariate analysis alone.

[Insert Table 2 about here]

Table 3 reports the correlation coefficients between the independent variables employed in the multivariate analysis. The correlations between segment-median PPS and fund PPS, between alternative dummy*PPS and segment-median PPS, between emerging dummy*PPS and segment-median PPS, and between segment-median PPS and segment-median fund return volatility are significantly high, but in each of these pairs the two variables are not tested in the same regression. All correlations between pairs of variables used in the same regression are below 0.3. This means that the detection tolerance of each pair of variables used in the same regression is larger than 0.7 and the variation inflation factor (VIF) of each pair is smaller than 1.429. O'Brien (2007) proves that a tolerance of less than 0.2 and/or a VIF of five or more indicates a multicollinearity problem. Therefore, there seem to be no multicollinearity problems for any of the independent variables used in the same regression in this study. The empirical results of the multivariate analyses are discussed in the following subsection.

[Insert Table 3 about here]

4.2 Simultaneous Equation

As discussed in the literature review and methodology sections, it is critical to account for the endogenous relationship between fund PPS and fund risk by applying simultaneous equation models to investigate how they affect one another.

Table 4 shows the results of the simultaneous equation models that jointly examine the determinants of fund PPS and the level of fund risk for the full sample of 2,351 fund-year observations. We report both the coefficients and the significance levels for all variables. For the simultaneous examinations, we use contemporaneous values for fund return volatility, fund PPS and all the control variables. The two models in the table are estimated simultaneously using the instrumental variables approach, following equations (1) and (2). The predicted values of fund PPS and fund return volatility are computed by regressing against all the exogenous variables in the system and their instruments. The instrumental variables are the segment-median PPS for fund PPS and the segment-median return volatility for fund return volatility.

[Insert Table 4 about here]

In the simultaneous equations system, predicted fund PPS has a significantly positive effect on fund return volatility. A 1% increase in PPS would increase fund return volatility by 5.239% (8.834% of its standard deviation). This further confirms Hypothesis 2. Consistent with Hypothesis 3, this enhance would increase to 12.607% for funds investing in alternative assets, to 11.607% for funds investing in emerging markets, and to 18.975% for funds investing in alternative assets in emerging markets. Predicted fund return volatility has a positive impact on fund PPS, and fund PPS would increase by 0.012% (4.33% of its standard deviation) with a 1% increase in fund return volatility. This result therefore supports Hypothesis 1. A 1% increase in fund return volatility would increase the fund PPS by 0.014% (5.05% of its standard deviation) for funds investing in alternative assets, by 0.013% (4.69% of its standard deviation) for funds investing in emerging markets, and by 0.015% (5.42% of its standard deviation) for funds investing in alternative assets in emerging markets. Again, this result supports Hypothesis 3. In addition, a 1% increase in the expense ratio or turnover ratio would increase fund PPS by 0.15% (54.15% of its standard deviation) or 0.001% (0.36% of its standard deviation), respectively. A 0.1% increase in the segment-median PPS would increase fund PPS by 0.074% (26.71% of its standard deviation). A one-unit decrease in Lnsize and a one-year reduction in fund age would increase fund PPS by 0.013% (4.69% of its standard deviation) and 0.002% (0.72% of its standard deviation), respectively. To summarize, the results of the simultaneous equation models testing how the level of fund return volatility and fund PPS are jointly determined are consistent with Hypotheses 1 to 3.

4.3 Robustness checks

PPS and return volatility are determined simultaneously and are highly auto-correlated, leading to the conclusion that lagged PPS is endogenous to current return volatility (or lagged return volatility is endogenous to current PPS). This conclusion is supported by the results of the endogeneity tests on lagged fund return volatility in Model 1 of Appendix Table 1 and on lagged PPS in Model 1 of Appendix Table 2, of the Wu-Hausman F-test and the Durbin-Wu-Hausman chi-square test. Previous literature, such as Kini and Williams (2012), uses lagged independent variables to alleviate, but does not eliminate, issues related to endogeneity in the OLS approach. They also use both the 2SLS regression approach (lagged independent variables) and the simultaneous equation approach (contemporaneous independent variables) to better account for the endogeneity.

Following this, we also conduct 2SLS regressions as a robustness check in the appendix. The results are consistent with those from simultaneous equations. The segment-median lagged fund return volatility (median standard deviation of monthly NAV returns across all funds in the same segment over the previous sample year) is used as an instrument in Model 2 of Appendix Table 1. The F-test statistic on the validity of the instrumental variable is 18.725 and is statistically significant, proving that the instrument is valid. The segment-median lagged fund PPS (median applicable marginal compensation rate across all funds in the same segment during the previous sample year) is used as an instrument in Model 2 of Appendix Table 2. The F-test statistic for the validity of the instrumental variable is 203.56 and is highly statistically significant. This proves that the instrument is valid.

5 Conclusions

This paper takes advantage of the transparent PPS information in management contracts for closed-end funds and studies how fund risk-taking behavior and fund PPS are interrelated for the closed-end fund industry. We use simultaneous equation models based on a sample of 2,351 fund-year observations of US closed-end funds traded on the New York Stock Exchange, the American Stock Exchange and the NASDAQ Stock Exchange between 2006 and 2009. We find that they positively influence each other. Moreover, the positive relationship between fund return volatility and fund PPS is more intensive for closed-end funds making alternative investments or investing in emerging markets.

This study contributes to the literature on management incentives, decisions on risk-taking behavior and corporate governance as a whole. The positive effect of fund risk on fund PPS supports the predictions of the managerial ownership model in Demsetz and Lehn (1985), but is contrary to the implications of the standard principal-agent model in Holmstrom and Milgrom (1987). Fund risk-taking behavior is positively affected by fund PPS, which indicates that, out of the two incentives provided by PPS, the increase in the value of a closed-end fund manager's compensation outweighs the negative effect increased volatility has on her expected utility.

Cumming et al. (2015) find that mutual fund outsourcing could have an impact on fund risk. Specifically, they find that outsourcing advisor services is associated with both greater fund risk and risk-adjusted performance. Future research could examine the relationship between PPS and outsourcing services among mutual funds.

References

Admati, A. R. and P. Pfleiderer (1997). "Does It All Add Up? Benchmarks and the Compensation of Active Portfolio Managers". The Journal of Business **70**(3): 323-350.

Aggarwal, R. and A. Samwick (1999). "The Other Side of the Trade-off: The Impact of Risk on Executive Compensation". Journal of Political Economy **107**: 65-105.

Aggarwal, R. K. and A. A. Samwick (2002). "The Other Side of the Tradeoff: The Impact of Risk on Executive Compensation - A Reply". SSRN eLibrary.

Amihud, Y. and B. Lev (1981). "Risk reduction as a managerial motive for conglomerate mergers". Bell Journal of Economics **12**: 605-617.

Bekaert, G. and M.S. Urias (1996). "Diversification, Integration and emerging market closed-end funds". Journal of Finance **51**(3): 835-869.

Billett, M. T., T. D. King and D. C. Mauer (2007). "Growth opportunities and the choice of leverage, debt maturity, and covenants". Journal of Finance **62**: 697-730.

Bloom, M. and G. T. Milkovich (1998). "Relationships among Risk, Incentive Pay, and Organizational Performance". Academy of Management Journal **41**(3): 283-297.

Buraschi, A., R. Kosowski, and W. Sritrakul (2014). "Incentives and endogenous risk taking: a structural view on hedge fund alphas". Journal of Finance **69**(6):2819-2870.

Carpenter, J. (2000). "Does option compensation increase managerial risk appetite?" Journal of Finance **55**: 2311-2331.

Cashman, G. D. (2010). "Pay-performance sensitivity and firm size: Insights from the mutual fund industry". Journal of Corporate Finance **16**(4): 400-412.

Coles, J. L., N. D. Daniel and L. Naveen (2006). "Managerial incentives and risk-taking". Journal of Financial Economics **79**(2): 431-468.

Coles, J. L., N. D. Daniel and L. Naveen (2009). "Co-opted Boards: Costs, Benefits, Causes, and Consequences". Working paper.

Coles, J. L., J. Suay and D. Woodbury (2000). "Fund Advisor Compensation in Closed-End Funds". The Journal of Finance **55**(3): 1385-1414.

Copeland, T. and J. Weston (1988). "Financial Theory and Corporate Policy". Addison-Wesley Publishing Co., Reading, MA.

Core, J. and W. Guay (1999). "The use of equity grants to manage optimal equity incentive levels". Journal of Accounting and Economics **28**(2): 151-184.

Core, J. E. and W. R. Guay (2002). "The Other Side of the Trade-Off: The Impact of Risk on Executive Compensation: A Revised Comment". SSRN eLibrary.

Cumming, D., Schwienbacher, A., and Zhan, F. (2015). "The scope of international mutual fund outsourcing: Fees, performance and risks". Journal of International Financial Markets, Institutions and Money **38**: 185-199.

Dee, C. C., A. Lulseged and T. S. Nowlin (2005). "Executive compensation and risk: The case of internet firms". Journal of Corporate Finance **12**(1): 80-96.

Deli, D. N. (2002). "Mutual Fund Advisory Contracts: An Empirical Investigation". The Journal of Finance **57**(1): 109-133.

Demsetz, H. and K. Lehn (1985). "The Structure of Corporate Ownership: Causes and Consequences". The Journal of Political Economy **93**(6): 1155-1177.

Eisenhardt, K. M. (1989). "Agency theory: An assessment and review". Academy of Management Review **14**: 57-74.

Gillan, S. L., J. C. Hartzell and R. Parrino (2009). "Explicit versus Implicit Contracts: Evidence from CEO Employment Agreements". The Journal of Finance **64**(4): 1629-1655.

Gormley, T., D. Matsa and T. Milbourn (2010). "CEO Compensation and Corporate Risk Taking: Evidence from a Natural Experiment". Unpublished working paper. Northwestern University and Washington University in St.Louis.

Grinblatt, M. and S. Titman (1989). "Adverse Risk Incentives and the Design of Performance-Based Contracts". Management Science **35**(7): 807-822.

Hall, B. J. and J. B. Liebman (1998). "Are CEOs really paid like bureaucrats?" Quarterly Journal of Economics **113**: 653-691.

Haugen, R. and L. Senbet (1981). "Resolving the agency problems of external capital through options". Journal of Finance **36**: 629-648.

Hemmer, T., O. Kim and R. E. Verrecchia (1999). "Introducing convexity into optimal compensation contracts". Journal of Accounting and Economics **28**: 307-327.

Hirshleifer, D. and R. Suh (1992). "Risk, managerial effort, and project choice". Journal of Financial Intermediation **2**: 308-345.

Holmstrom, B. and P. Milgrom (1987). "Aggregation and Linearity in the Provision of Intertemporal Incentives". Econometrica **55**: 303-328.

Huang, Y. T., M.C. Wu and S. L. Liao (2013). "The relationship between equity-based compensation and managerial risk taking: evidence from China". Emerging Markets Finance and Trade **49**(2): 107-125.

Jensen, M. C. and W. H. Meckling (1976). "Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure". Journal of Financial Economics **3**: 305-360.

Jensen, M. C. and K. J. Murphy (1990). "Performance pay and top-management incentives". Journal of Political Economy **98**(2): 225-264.

Jin, L. (2002). "CEO compensation, diversification, and incentives". Journal of Financial Economics **66**(1): 29-63.

John, K. and L. Litov (2009). "Corporate Governance and Financing Policy: New Evidence". New York University working paper.

John, K., L. Litov and B. Yeung (2008). "Corporate Governance and Risk-Taking". The Journal of Finance **63**(4): 1679-1728.

John, T. and K. John (1993). "Top-management compensation and capital structure". Journal of Finance **48**: 949-974.

Kemf, A. S. Ruenzi and T. Thiele (2009). "Employment risk, compensation incentives, and managerial risk taking: evidence from the mutual fund industry". Journal of Financial Economics **92**: 92-108.

Kimmel, P., L. Kren and M. Schadewald (1995). "Effect of Risk on the Use of Performance-Contingent Compensation". Managerial Finance **21**: 36-51.

King, T.-H. D. and M.-M. Wen (2011). "Shareholder governance, bondholder governance, and managerial risk-taking". Journal of Banking & Finance **35**(3): 512-531.

Kini, O. and R. Williams (2012). "Tournament incentives, firm risk, and corporate policies". Journal of Financial Economics **103**(2): 350-376.

Lambert, R. (1986). "Executive effort and the selection of risky projects". Rand Journal of Economics **17**: 77-88.

Lambert, R. and D. Larcker (1987). "An analysis of the use of accounting and market measures of performance in executive compensation contracts". Journal of Accounting Research **25**: 85-125.

Lambert, R., D. Larcker and R. Verrecchia (1991). "Portfolio considerations in valuing executive compensation". Journal of Accounting Research **29**: 129-149.

Lewellen, K. (2006). "Financing decisions when managers are risk-averse". Journal of Financial Economics **82**: 551-590.

Low, A. (2009). "Managerial risk-taking behavior and equity-based compensation". Journal of Financial Economics **92**(3): 470-490.

Massa, M. and R. Patgiri (2009). "Incentives and Mutual Fund Performance: Higher Performance or Just Higher Risk Taking?" Review of Financial Studies **22**(5): 1777-1815.

Miller, J. S., R. M. Wiseman and L. R. Gomez-Mejia (2002). "The Fit between CEO Compensation Design and Firm Risk". The Academy of Management Journal **45**(4): 745-756.

Mirrless, J. (1974). "Notes on Welfare Economics, Information, and Uncertainty". Essays on Economic Behavior under Uncertainty. Amsterdam: North-Holland.243-257.

Mirrless, J. (1976). "The Optimal Structure of Incentives and Authority within an Organization". The Bell Journal of Economics **7**: 105-131.

Murphy, K. J. (1999). "Executive compensation". Handbook of Labor Economics **3b**: 2485-2563.

O'Brien, R. M. (2007). "A Caution Regarding Rules of Thumb for Variance Inflation Factors". Quality and Quantity **41**(5): 673-690.

Prendergast, C. (2000). "What Trade-Off of Risk and Incentives?" The American Economic Review **90**(2): 421-425.

Prendergast, C. (2002). "The Tenuous Trade-Off between Risk and Incentives". The Journal of Political Economy **110**(5): 1071-1102.

Roberts, M. R. and T. M. Whited (2011). "Endogeneity in empirical corporate finance". Working paper. University of Pennsylvania and University of Rochester.

Ross, S. A. (1973). "The Economic Theory of Agency: The Principal's Problem". American Economic Review **63**: 134-139.

Ross, S. A. (2004). "Compensation, Incentives, and the Duality of Risk Aversion and Riskiness". The Journal of Finance **59**(1): 207-225.

Shavell, S. (1979). "Risk Sharing and Incentives in the Principal and Agent Relationship". Bell Journal of Economics **10**: 55-73.

Smith, C. and R. Stulz (1985). "The determinants of firms' hedging policies". Journal of Financial and Quantitative Analysis **4**: 391-405.

Stiglitz, J. E. (1987). "The design of labor contracts: The economics of incentives and risk-sharing". Incentives, cooperation and risk sharing (Eds.). Totowa, NJ. Rowan & Littlefield**:** 47-68.

Williams, J. (1987). "Perquisites, risk, and capital structure". Journal of Finance **42**: 29-48.

Table 1 Descriptive statistics

This table provides definitions and descriptive statistics for the dependent and independent variables used in the empirical analysis for the full sample of 2,351 fund-year observations from 2006 to 2009.

Variable Name	Definition	Obs	Mean	Median	Std Dev.	Min	Max
	Panel A: Measures of investment risk						
Vol	Standard deviation of monthly net asset value returns over each sample year; in (%)	2351	6.090	3.209	59.306	0.000	2818.707
Variable Name	**Definition**	**Obs**	**Mean**	**Median**	**Std Dev.**	**Min**	**Max**
	Panel B: Measure of fund pay-performance sensitivity						
PPS	For a linear contract, it is the single compensation rate specified in the contract each year, expressed as a percentage. For a concave contract, it is the compensation rate specified in the contract that corresponds to the NAV interval that contains the most recent year-end NAV, as reported in either the proxy statement or the annual report for the corresponding year, expressed as a percentage.	2351	0.684	0.650	0.277	0.000	1.860

Variable Name	Definition	Obs	Mean	Median	Std Dev.	Min	Max
			Panel C: Control variables				
AT	Equals one if the closed-end fund invests in assets rather than equity, and equals zero if the fund invests in traditional equity.	2351	0.191	0.000	0.393	0.000	1.000
EM	Equals one if the closed-end fund invests in emerging markets, and equals zero if the fund invests in developed markets.	2351	0.059	0.000	0.235	0.000	1.000
LIC	Equals one if the management contract contains a single marginal compensation rate, and equals zero if the contract contains a series of marginal compensation rates declining with the increase of the fund size.	2351	0.662	1.000	0.473	0.000	1.000
Lagvol	Standard deviation of monthly net asset value returns over the previous year; in (%)	2351	4.930	1.893	59.756	0.000	2818.707
EXR	Total expenses as a percentage of net asset value during the sample year; in (%)	2351	1.253	1.160	0.535	0.110	8.160
TNR	Absolute value of the difference between sales and purchases as a percentage of average monthly NAV for the sample year; in (%).	2351	48.672	31.000	64.029	0.600	999.000
Size	Average monthly net asset value of the fund during the sample year; in ($ million)	2351	510.941	310.503	609.074	0.000	7667.545
Lnsize	Logarithm of the average monthly net asset value of the fund during the sample year.	2351	19.524	19.562	1.059	15.504	22.760

Age	Number of years since the fund's inception.	2351	11.435	9.572	10.187	0.016	85.492
Mvol	Median standard deviation of monthly net asset value returns of all funds in the same segment over each sample year; in (%)	2351	3.664	3.499	2.505	1.011	10.733
MPPS	Median manager's applicable marginal compensation rate of all funds in the same segment during each sample year; in (%)	2351	0.675	0.550	0.191	0.520	1.000

Table 2 Univariate analysis

This table performs a univariate analysis on the mean values of the main variables in this paper: fund PPS and fund return volatility. It compares the mean values of fund PPS between two subsamples: with below and above the median value of fund return volatility. It also compares the mean values of fund return volatility between two subsamples: with below and above the median value of fund PPS. The difference in means and p-values for the standard t-test of differences between the means of two unpaired samples are reported in the last two columns of the table, respectively. The definitions of these two main variables are shown in Table 1.

Variable	Obs	Mean	Difference in Mean	P-value of difference in Mean
PPS:				
Fund return volatility below median	1175	0.60	-0.165	0.000
Fund return volatility above median	1175	0.77		
Fund return volatility:				
PPS below median	1175	5.61	-0.907	0.036
PPS above median	1175	6.52		

Table 3 Correlation matrix

This table reports the correlation coefficients between the independent variables used in the multivariate analysis. Median PPS and PPS are significantly highly correlated at 0.664. Alternative dummy*PPS and median PPS are highly correlated at 0.601. Emerging dummy*PPS and median PPS are correlated at 0.561.The correlation between median PPS and median fund return volatility is significant at 0.686. However, in none of these pairs are the two variables used in the same regression for the multivariate analysis. All other correlations are below 0.3. The detection-tolerance of every pair of variables is larger than 0.7, and the variation inflation factor (VIF) of any pair of variables is smaller than 1.429. This means there is no multicollinearity problem for any of the independent variables used in the same regression. All variables are defined in Table 1. Bold correlations indicate significance at the 1% level.

Variables	Vol_t	PPS_t	AT_t $\times PPS_t$	EM_t $\times PPS_t$	AT_t $\times Vol_t$	EM_t $\times Vol_t$	AT_t	EM_t	LIC_t	EXR_t	TNR_t	$Lnsize_t$	Age_t	Vol_{t-1}	$Mvol_t$	$MPPS_t$
Vol_t	1.000															
PPS_t	0.011	1.000														
$AT_t \times PPS_t$	0.002	0.038	1.000													
$EM_t \times PPS_t$	0.007	0.045	0.122	1.000												
$AT_t \times Vol_t$	0.045	0.001	0.153	0.006	1.000											
$EM_t \times Vol_t$	0.020	0.002	0.132	0.009	0.061	1.000										
AT_t	0.001	0.030	0.065	0.010	0.031	0.021	1.000									
EM_t	0.007	0.016	0.031	0.050	0.015	0.012	0.009	1.000								
LIC_t	-0.022	0.101	0.082	-0.099	0.080	-0.123	0.060	-0.098	1.000							
EXR_t	0.006	0.127	0.257	0.123	0.255	0.102	0.216	0.112	0.146	1.000						
TNR_t	-0.005	0.201	0.102	0..056	0.040	0.049	0.103	0.057	0.120	0.123	1.000					
$Lnsize_t$	0.008	0.138	0.123	0.026	0.026	0.167	0.118	0.027	0.234	-0.223	0.098	1.000				
Age_t	-0.014	-0.156	-0.153	0.092	-0.029	0.088	0.014	0.093	-0.214	-0.054	-0.084	0.018	1.000			
Vol_{t-1}	0.002	0.010	0.001	0.012	0.011	0.016	-0.001	0.012	-0.230	0.004	-0.004	0.014	-0.007	1.000		
$Mvol_t$	0.029	0.159	0.155	0.247	0.274	0.102	0.131	0.235	-0.007	0.195	0.183	0.091	0.022	0.013	1.000	
$MPPS_t$	0.013	**0.664**	**0.601**	**0.561**	0.260	0.213	0.235	0.263	0.023	0.246	0.247	0.213	-0.003	0.017	**0.686**	1.000

Table 4 Simultaneous equation estimation

This table presents the results of simultaneous equation models that examine how the fund PPS and the level of fund risk are jointly determined, for the full sample of 2,351 fund-year observations from 2006 to 2009. The dependent variable in the first regression is fund return volatility, and in the second regression it is fund PPS. Predicted fund PPS is estimated by regressing on the instrument of segment-median PPS and other exogenous variables. Predicted fund return volatility is estimated by regressing on the instrument of segment-median return volatility and other exogenous variables. The first regression is based on equation (5) and the second on equation (6). All variables are defined in Table 1. We report coefficients and significance levels for each model.

Estimation type	Simultaneous equations (3SLS)			
Dependent variable	Vol_t		PPS_t	
	Coefficient	P-value	Coefficient	P-value
$Prevol_t$			0.012	0.022
$PrePPS_t$	5.239	0.032		
$AT_t \times Prevol_t$			0.002	0.039
$EM_t \times Prevol_t$			0.001	0.047
$AT_t \times PrePPS_t$	7.368	0.027		
$EM_t \times PrePPS_t$	6.368	0.030		
AT_t	1.946	0.027	0.079	0.059
EM_t	1.179	0.020	0.061	0.088
LIC_t	0.497	0.148	0.005	0.960
EXR_t	1.910	0.002	0.150	0.008
TNR_t	-0.001	0.224	0.001	0.005
$Lnsize_t$	0.602	0.007	-0.013	0.006
Age_t	-0.062	0.650	-0.002	0.005
Vol_{t-1}	0.001	0.592		
$Mvol_t$	1.019	0.003		
$MPPS_t$			0.743	0.007
Year2006	-1.713	0.035	0.043	0.717
Year2007	-1.213	0.028	0.020	0.925
Year2009	-0.592	0.061	0.003	0.972
Foreignbond	-0.574	0.076	0.121	0.579
Domesticequity	0.063	0.690	0.099	0.541
Domesticbond	-0.446	0.136	0.463	0.280
Constant	-13.588	0.683	-0.360	0.002
No.Observation	2351		2351	
Adjusted R^2	0.513		0.679	

Appendix Table 1

Risk effect on fund management pay-performance sensitivity

This table presents the OLS regression and 2SLS regression results of the risk effect on fund PPS for the full sample of 2,351 fund-year observations from 2006 to 2009. The dependent variable is the applicable marginal compensation rate denoted in the management contract as a percentage. The Wu-Hausman F-test and the Durbin-Wu-Hausman chi-squared test are used to examine the endogeneity of lagged fund return volatility. A 2SLS regression is used to address the endogeneity problem of the OLS regression. The instrument used in the 2SLS regression is segment-median lagged fund return volatility (median standard deviation of monthly NAV returns across all funds in the same segment over the previous sample year); the instrument's validity is examined using an F-test, and the results are presented in the lower part of the table. Model 1 is based on equation (1) and Model 2 on equation (2). All variables are defined in Table 1. We report coefficients and p-values for each model.

	Dependent variable: PPS_t			
	OLS		IV(2SLS)	
Independent variable	Model 1		Model 2	
	Coefficient	P-value	Coefficient	P-value
Vol_{t-1}	0.002	0.076		
$AT_t \times Vol_{t-1}$	0.001	0.082		
$EM_t \times Vol_{t-1}$	0.001	0.090		
$Prevol_{t-1}$			0.005	0.028
$AT_t \times Prevol_{t-1}$			0.002	0.036
$EM_t \times Prevol_{t-1}$			0.001	0.045
AT_t	0.024	0.051	0.056	0.079
EM_t	0.016	0.067	0.048	0.083
LIC_t	0.001	0.346	0.002	0.496
EXR_t	0.096	0.000	0.123	0.021
TNR_t	0.001	0.000	0.001	0.001
$Lnsize_t$	-0.013	0.000	-0.017	0.004
Age_t	-0.003	0.000	-0.004	0.035
$MPPS_t$	0.313	0.000	0.198	0.033
Year2006	-0.001	0.996	-0.002	0.980
Year2007	0.008	0.451	0.057	0.609
Year2009	-0.001	0.923	-0.056	0.643
Foreignbond	-0.051	0.068	-0.068	0.681
Domesticequity	0.032	0.080	0.032	0.759
Domesticbond	0.064	0.300	0.054	0.876
Constant	0.012	0.210	0.102	0.748
No.Observation	2351		2351	
Adjusted R^2	0.586		0.612	

Tests of endogeneity of Vol_{t-1} for OLS Model 1		
H_0: Regressor is exogenous		
Wu-Hausman F test: F(1, 2336)	5.367	P-value = 0.023
Durbin-Wu-Hausman chi-sq test: Chi-sq(1)	5.724	P-value = 0.021
F-test on the validity of the instrument used for IV (2SLS) Model 2		
H_0: The instrument variable ($Mvol_{t-1}$) is invalid		
F-statistic: 18.725		
P-value: 0.000		

Appendix Table 2

The effect of fund management pay-performance sensitivity on the level of risk-taking

This table presents the OLS regression and 2SLS regression results for the impact of fund PPS on the level of risk-taking for the full sample of 2,351 fund-year observations from 2006 to 2009. The dependent variable is the volatility of fund investment performance, as a percentage. The Wu-Hausman F-test and the Durbin-Wu-Hausman chi-squared test are used to examine the endogeneity of lagged fund PPS. A 2SLS regression is used to address the endogeneity problem of the OLS regression. The instrument used in the 2SLS regression is segment-median lagged fund PPS (median applicable marginal compensation rate across all funds in the same segment during the previous sample year); the instrument's validity is examined using an F-test, and the results are presented in the lower part of the table. Model 1 is based on equation (3) and Model 2 on equation (4). All variables are defined in Table 1. We report coefficients and p-values for each model.

	Dependent variable: Vol_t			
	OLS		IV(2SLS)	
Independent variable	Model 1		Model 2	
	Coefficient	P-value	Coefficient	P-value
PPS_{t-1}	1.276	0.056		
$AT_t \times PPS_{t-1}$	1.106	0.068		
$EM_t \times PPS_{t-1}$	0.688	0.088		
$PrePPS_{t-1}$			3.601	0.022
$AT_t \times PrePPS_{t-1}$			2.917	0.027
$EM_t \times PrePPS_{t-1}$			1.389	0.016
AT_t	0.745	0.068	0.812	0.087
EM_t	0.173	0.092	0.233	0.088
Vol_{t-1}	0.000	0.985	0.000	0.966
LIC_t	0.084	0.141	0.143	0.259
EXR_t	0.836	0.008	2.150	0.004
TNR_t	-0.001	0.871	-0.003	0.890
$Lnsize_t$	0.072	0.004	0.315	0.005
Age_t	-0.012	0.303	-0.021	0.575
$Mvol_t$	0.959	0.004	1.056	0.004
Year2006	-0.749	0.044	-1.042	0.059
Year2007	-0.219	0.081	-0.575	0.071
Year2009	-0.181	0.072	-0.313	0.065
Foreignbond	-0.254	0.082	-1.841	0.877
Domesticequity	0.350	0.584	0.481	0.545

Domesticbond	-0.495	0.617	0.837	0.959
Constant	-10.849	0.095	-10.643	0.049
No.Observation	2351		2351	
Adjusted R^2	0.415		0.713	

Tests of endogeneity of PPS_{t-1} for OLS Model

H_0: Regressor is exogenous

Wu-Hausman F test: 5.126 F(1, 2335) P-value = 0.031

Durbin-Wu-Hausman chi-sq test: 5.232 P-value = 0.025

Chi-sq(1)

F-test on the validity of the instrument used for IV (2SLS) Model 2

H_0: The instrument variable ($MPPS_{t-1}$) is invalid

F-statistic: 203.56

P-value: 0.000